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| APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents</i> | ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, D.C. 20231 |
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| 2. <input checked="" type="checkbox"/> Specification <i>[Total Pages 29]</i> <i>(preferred arrangement set forth below)</i> <ul style="list-style-type: none">- Descriptive title of the Invention- Cross References to Related Applications- Statement Regarding Fed sponsored R & D- Reference to Microfiche Appendix- Background of the Invention- Brief Summary of the Invention- Brief Description of the Drawings <i>(if filed)</i>- Detailed Description- Claim(s)- Abstract of the Disclosure | 7. Nucleotide and/or Amino Acid Sequence Submission <i>(if applicable, all necessary)</i> <ul style="list-style-type: none">a. <input type="checkbox"/> Computer Readable Copyb. <input type="checkbox"/> Paper Copy (identical to computer copy)c. <input type="checkbox"/> Statement verifying identity of above copies |
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| 4. Oath or Declaration <i>[Total Pages - 2]</i> <ul style="list-style-type: none">a. <input type="checkbox"/> Newly executed <i>(original or copy)</i>b. <input checked="" type="checkbox"/> Copy from a prior application <i>(37 CFR 1.63(d))</i> <i>(for continuation/divisional with Box 17 completed)</i> [Note Box 5 below]<ul style="list-style-type: none">i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b). | 8. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) |
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of :
Kanji HATA et al. :
Serial No. [NEW] : Attn: APPLICATION BRANCH
Filed January 21, 1998 : Docket No. 177/527415
COMPONENT MOUNTING APPARATUS AND
METHOD, AND COMPONENT MOUNTING
EQUIPMENT :
(Continuation of 08/740,992,
filed November 5, 1996)

PATENT OFFICE FEE TRANSMITTAL FORM

Assistant Commissioner for Patents,
Washington, D.C.

Sir:

Attached hereto is a check in the amount of \$790.00 to cover Patent Office fees relating to filing the following attached papers:

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The Commissioner is authorized to charge any deficiency or to credit any overpayment associated with this communication to Deposit Account No. 23-0975, with the EXCEPTION of deficiencies in fees for multiple dependent claims in new applications.

Respectfully submitted,

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1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

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1. The first part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as $t \rightarrow \infty$. It is shown that the solutions of the system (1) are bounded and tend to zero as $t \rightarrow \infty$ if the matrix A is stable. The second part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as $t \rightarrow \infty$ if the matrix A is not stable. It is shown that the solutions of the system (1) are unbounded and tend to infinity as $t \rightarrow \infty$ if the matrix A is not stable.

1. The first part of the document is a title page. It contains the title "THE HISTORY OF THE UNITED STATES OF AMERICA" and the author "BY JAMES MADISON".

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showing a perspective view of it and Fig. 7 showing a schematic plan view of it. In Fig. 6, at the front of an apparatus body 1 is provided a board positioning section 4 for positioning a circuit board P supplied from a board supply means 2 in a mounting position, and the circuit board P mounted with the required components in the board positioning section 4 is discharged by a board discharge means 3. On the other hand, at the rear of the apparatus body 1 is provided a component supply section 7, and a rotary type mounting head section 8 is provided between the component supply section 7 and the aforementioned board positioning section 4 as shown in Fig. 7.

In the component supply section 7 are laterally movably provided two component supply tables 10 and 11 independently of each other on a guide rail 9. The component supply tables 10 and 11 are mounted with a number of component supply means 12 arranged in parallel to one another in a direction in which the component supply tables 10 and 11 move. There is illustrated generally so-called the parts cassette as the component supply means 12, and it will be simply described below. That is, electronic components of an identical type are stored as arranged at regular intervals on a carrier tape while being wound around a reel 13 as covered with a cover tape. By drawing out the carrier tape from the reel 13 to feed it at a pitch

equal to the storage intervals of the components and taking
up the cover tape, the electronic component located at the
leading end is positioned in a component supply position A
opposite to a component suction head 14 of the mounting
5 head section 8.

Furthermore, as shown in Fig. 7, the mounting
head section 8 is constructed by providing a plurality of
component suction heads 14 at regular angular intervals on
an identical circle of a rotary table (not shown) provided
10 rotatably around a vertical axis. Each component suction
head 14 is designed to suck a component by vacuum suction
means. Upon intermittently rotating the rotary table, it
is stopped in steps in the component supply position A and
a component mounting position B in order to concurrently
15 perform receiving of each component from the component
supply means 12 and mounting of each component onto the
circuit board P. While one component supply table 10 is
supplying components, the other component supply table 11
that is retreating in a standby position performs changing
20 of component supply means 12 and replenishing of components
thereby achieving preparation so that the component
mounting apparatus can be operated incessantly.

In recent years, there has been a growing trend
that the types of circuit boards P to be manufactured and
25 the types of components to be mounted on the circuit boards

P are increasing. In order to cope with the above, it can be considered to increase the number of component supply means 12 to be mounted to the component supply tables 10 and 11. However, in such a case, the component supply tables 10 and 11 are to be elongated sidewise according to the increase in number of the component supply means 12 to be mounted. Consequently, the length of the entire component supply section 7 becomes very long, and this leads to a degraded space utilization efficiency, reducing the productivity per floor area.

A more important issue is that the component supply tables 10 and 11 are fed at a pitch in accordance with taking out the components by the mounting head section 8, and therefore, the following inconvenience occurs. That is, when the component supply tables 10 and 11 increase in weight according to the increase of their lengths, not only a great drive power is required to move the component supply tables 10 and 11 but also the inertial force of the component supply tables 10 and 11 increases. Therefore, vibration in feeding the component supply tables 10 and 11 at a pitch significantly increases. Consequently, it is impossible to increase the component supply rate, or the component mounting operation speed.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present

invention to provide component mounting apparatus and method capable of increasing the component mounting operation speed without dimensionally increasing the whole apparatus even when the types of boards and the number of components to be mounted on each board increase, and a component mounting apparatus employing the apparatus.

In accomplishing these and other objects, according to a first aspect of the present invention, there is provided a component mounting apparatus comprising:

10 a pair of component supply tables on which components are accommodated and which are arranged on both sides of a board mounting position where a board is positioned;

a first mounting head section for successively picking up the components at one of the component supply tables and thereafter successively mounting the picked-up components onto the board; and

15 a second mounting head section for successively picking up the components at the other of the component supply tables and thereafter successively mounting the picked-up components onto the board,

wherein the first and second mounting head sections are independently operated.

According to a second aspect of the present invention, there is provided the component mounting

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apparatus as claimed in the first aspect, wherein the first and second mounting head sections are controlled mutually in operation in accordance with a timing at which, when one of them carries out a component picking-up operation for picking up the components from the component supply table, the other of them carries out a component mounting operation for mounting the picked-up components onto the board.

According to a third aspect of the present invention, there is provided the component mounting apparatus as claimed in the first aspect, wherein one of the first and second mounting head section has component suction nozzles sucking the components at one time.

According to a fourth aspect of the present invention, there is provided the component mounting apparatus as claimed in the second aspect, wherein one of the first and second mounting head section has component suction nozzles sucking the components at one time.

According to a fifth aspect of the present invention, there is provided a component mounting equipment comprising:

a plurality of component mounting apparatuses each of which is claimed in the first aspect,

wherein a board transfer path along which the board is supplied to the board mounting position of the apparatus

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and discharged from the board mounting position of the apparatus by a board transfer device is provided so that the board transfer path connects the board mounting positions of the component mounting apparatuses, and the
5 component supply tables of the component mounting apparatuses are arranged on both sides of the board mounting positions in the board transfer path.

According to a sixth aspect of the present invention, there is provided a component mounting equipment
10 comprising:

a plurality of component mounting apparatuses each of which is claimed in the second aspect,

wherein a board transfer path along which the board is supplied to the board mounting position of the apparatus
15 and discharged from the board mounting position of the apparatus by a board transfer device is provided so that the board transfer path connects the board mounting positions of the component mounting apparatuses, and the component supply tables of the component mounting
20 apparatuses are arranged on both sides of the board mounting positions in the board transfer path.

According to a seventh aspect of the present invention, there is provided the component mounting equipment as claimed in the fifth aspect, wherein the
25 components to be mounted onto the single board are all

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distributed into groups by type, and the components of the groups are accommodated in the component supply tables of the component mounting apparatuses as assigned thereto.

According to an eighth aspect of the present invention, there is provided the component mounting equipment as claimed in the sixth aspect, wherein the components to be mounted onto the single board are all distributed into groups by type, and the components of the groups are accommodated in the component supply tables of the component mounting apparatuses as assigned thereto.

According to a ninth aspect of the present invention, there is provided a component mounting method comprising steps of:

picking up by a first mounting head section components from one of a pair of component supply tables on which the components are accommodated and which are arranged on both sides of a board mounting position where a board is positioned, the first mounting head section successively picking up the components at one of the component supply tables;

thereafter successively mounting the components picked up by the first mounting head section onto the board;

picking up by a second mounting head section components from the other of the pair of component supply

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tables, the second mounting head section successively picking up the components at the other of the component supply tables; and

thereafter successively mounting the components
5 picked up by the second mounting head section onto the board,

wherein the picking-up and mounting steps of the first mounting head section and the picking-up and mounting steps of the second mounting head section are independently
10 carried out.

According to a tenth aspect of the present invention, there is provided the component mounting method as claimed in the ninth aspect, wherein the picking-up step of the first mounting head section and the mounting step of
15 the second mounting head section are carried out at the same time, and the mounting step of the first mounting head section and the picking-up step of the second mounting head section are carried out at the same time.

According to an eleventh aspect of the present
20 invention, there is provided the component mounting method as claimed in the ninth aspect, wherein in a component mounting equipment comprising a plurality of component mounting apparatuses each of which comprises the first and second mounting head sections and the pair of component
25 supply tables between which a board transfer path along

which the board is supplied to the board mounting position of the apparatus and discharged from the board mounting position of the apparatus by a board transfer device is provided so that the board transfer path connects the board mounting positions of the component mounting apparatuses, and the component supply tables of the component mounting apparatuses are arranged on both sides of the board mounting positions in the board transfer path,

the picking-up and mounting steps of the first mounting head section and the picking-up and mounting steps of the second mounting head section are sequentially carried out.

According to a twelfth aspect of the present invention, there is provided the component mounting method as claimed in the eleventh aspect, wherein the picking-up step of each of the first mounting head sections and the mounting step of each of the corresponding second mounting head sections are carried out at the same time, and the mounting step of each of the first mounting head sections and the picking-up step of each of the corresponding second mounting head sections are carried out at the same time.

According to a thirteenth aspect of the present invention, there is provided the component mounting equipment as claimed in the eleventh aspect, wherein the components to be mounted onto the single board are all

distributed into groups by type, and the components of the groups are accommodated in the component supply tables of the component mounting apparatuses as assigned thereto.

According to a fourteenth aspect of the present invention, there is provided the component mounting equipment as claimed in the twelfth aspect, wherein the components to be mounted onto the single board are all distributed into groups by type, and the components of the groups are accommodated in the component supply tables of the component mounting apparatuses as assigned thereto.

With the above arrangement, the component supply table is installed fixedly, and therefore, it becomes free of vibration regardless of the number of mounted component supply means which can be mounted thereon. The mounting head section is a robot type which sucks a plurality of components from the component supply table at one time and thereafter successively mounts the components to specified portions of the board. Therefore, even when the number of components to be mounted on a board increases, the component mounting operation speed can be remarkably increased further than in the conventional apparatus in which the component supply table is fed at a pitch with respect to the rotary type mounting head section.

Furthermore, components can be mounted by the two of the first and second mounting head sections onto the

board positioned in a single board mounting position, and therefore, the component mounting operation speed can be further increased.

With the above arrangement of the fifth and sixth
5 aspects and the eleventh and twelfth aspects, by mounting different components on the component supply tables installed at each of the component mounting apparatuses, the component supply tables are inevitably arranged on both
10 sides of the board transfer path along it even when the types and the number of components to be mounted onto the board increase. Therefore, the equipment does not dimensionally increase as a whole without expanding significantly in the direction of the board transfer path. Furthermore, the mounting head sections of the component
15 mounting apparatuses operate at high speed and the component supply tables are fixedly installed, and therefore, the component mounting operation speed can be increased.

With the above arrangement of the thirteenth and
20 fourteenth aspects, when the types of boards are increased, the equipment can cope with it only by replacing a specified one of the component supply tables installed at the respective component mounting apparatuses with a component supply table mounted with components of the
25 required type.

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These and other objects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

10 Fig. 2 is a perspective view of an embodiment of
the component mounting apparatus of the present invention,
the apparatus being a part of the above equipment;

15 Fig. 4 is a flow chart of the above apparatus;

Fig. 6 is a perspective view of a conventional component mounting apparatus; and

DETAILED DESCRIPTION OF THE EMBODIMENTS

Before the description of the present invention proceeds, it is to be noted that like parts are designated
25 by like reference numerals throughout the accompanying

drawings.

An embodiment of the present invention will be described below with reference to Figs. 1 through 4.

Fig. 1 is a schematic plan view schematically showing a component mounting equipment (component mounting line) according to an embodiment of the present invention. In the figure, four component mounting apparatuses 27A through 27D are provided along a board transfer path 21, and four board transfer means 22 are provided for the component mounting apparatuses 27A through 27D along the board transfer path 21 in the lateral direction so that each board transfer means 22 supplies a board to be mounted with components to a board mounting position of one of the component mounting apparatuses and discharges the board therefrom. The component mounting apparatuses 27A through 27D have an identical basic structure, and therefore, the component mounting apparatus 27D is taken as an example to be described below with reference to Fig. 2 that shows a perspective view of it and Fig. 3 that shows a plan view of its operating mechanism section.

In the component mounting apparatus 27D shown in Fig. 2, a laterally provided pair of inverted U-shaped support frames 29 are arranged in parallel to each other along the board transfer path 21 while allowing the board transfer path 21 to penetrate them. Between both the

support frames 29 are arranged two operating frames 30 in parallel to each other across the frames 29, and they are supported individually movably in a direction perpendicular to the board transfer path 21. To each operating frame 30
5 is mounted a mounting head section 31 movably along the operating frame 30. At the mounting head section 31, four component suction nozzles 33 are provided at regular intervals (at intervals of 90°) around a rotary member 32 that is rotatably supported around a horizontal axis. Upon
10 rotating the rotary member 32 at a pitch equal to each interval of the component suction nozzles 33, the component suction nozzles 33 are selectively and sequentially directed downward to suck a component 34 from a component supply table 28A and mount the sucked component 34 onto a
15 circuit board 37 located at the board mounting position where the board 37 is positioned by a board positioning section 24.

Between both the support frames 29 are inserted the component supply tables 28A from both depthwise sides
20 as moved by casters 40, and thereafter they are fixedly installed in specified positions. The component supply table 28A is provided with component supply means 12 comprised of parts cassettes provided with the aforementioned reels 13. Other than this, as shown in Fig.
25 1, a component supply table 28B mounted with a stick-shaped

component supply means 38 at which components stored in a pipe member are successively fed to a take-out position, a component supply table 28C on which bulk components 39 are placed, and a tray-shaped component supply table 28D are
5 installed at the component mounting apparatuses 27A through 27D. It is to be noted that the tray-shaped component supply table 28D is provided with a mounting head section 59 having a pivot arm shape for taking out the components thereof.

10 In Fig. 3, each operating frame 30 houses therein a head positioning mechanism section 41 for moving the mounting head section 31 in the lengthwise direction of the board transfer path 21.

The head positioning mechanism section 41 is
15 comprised of a ball thread 43 that is rotatably supported across a pair of support plates 42 fixed to both ends of each operating frame 30, a step motor 47 for rotatively driving the ball thread 43 via a connecting means 44, and a moving member 49 in which a nut 48 meshed with the ball
20 thread 43 is internally fixed and moved in accordance with the rotation of the ball thread 43. The mounting head section 31 is fixed to the moving member 49 via a head holder 50, and the head holder 50 is internally provided with a known head elevation mechanism section 51 for
25 vertically moving the mounting head section 31.

Each of the support frames 29 houses therein a head feed mechanism section 52 for moving the head positioning mechanism section 41 via each operating frame 30 in a direction perpendicular to the board transfer path 21. The head feed mechanism section 52 is comprised of a ball thread 54 that is rotatably supported across a pair of support plates 53 fixed to both ends of each support frame 29, a step motor 56 for rotatively driving the ball thread 54 via a connecting means 55, a moving member 57 that is fixed to an end portion of each operating frame 30 as meshed with the ball thread 54 and operates to move the operating frame 30 in accordance with the rotation of the ball thread 54, and a guide shaft 58 that is fixed across the support plates 53 and operates to slidably support the operating frame 30 while allowing the guide shaft 58 to penetrate the other end of the operating frame 30. A controller 100 controls the operations of the apparatuses 27A-27D and the board transfer means 22, because it is connected to them as shown in Fig. 5 in which the connection structure of the apparatus 27B is shown as one example. The other connection structure of the apparatuses 27A, 27C, and 27D are similar to the apparatus 27B.

The operation of the aforementioned component mounting equipment will be described next with reference to a flowchart of Fig. 4. In the component mounting

apparatuses 27A through 27D, the mounting head sections 31 are controlled in accordance with a timing at which, while one mounting head section 31 is sucking components 34 from one of the component supply tables 28A through 28D, the other mounting head section 31 mounts the components 34 onto the circuit board 37. Since both the mounting head sections 31 execute an identical operation except for an operating timing shift, only the operation of one mounting head section 31 will be now described.

10 First, the mounting head section 31 is moved to a position just above the component 34 to be sucked by suction on one of the component supply tables 28A through 28D and then positioned (step S1). That is, upon rotating the step motor 47 of the head positioning mechanism section 15 41 by a specified angle in the required rotational direction, the moving member 49 moves in the lengthwise direction of the board transfer path 21 by the ball thread 43 that is rotating integrally with the step motor 47, and the mounting head section 31 is moved to a specified component take-out position on the one of the component 20 supply tables 28A through 28D. In this stage, in regard to the other component supply tables 28A through 28C except for the tray-shaped component supply table 28D, the component take-out position is positioned in a straight 25 line extending along the board transfer path 21.

Consequently, the mounting head section 31 does not move as positioned in the position until such components as the parts cassette or the stick fronting the mounting head section 31 deplete.

5 When the mounting head section 31 is positioned, the head elevation mechanism section 51 operates to move down the mounting head section 31, the component suction nozzle 33 sucks a component 34, and thereafter the mounting head section 31 is slightly moved up by the head elevation
10 mechanism section 51 (step S2). Subsequently, the rotary member 32 of the mounting head section 31 is rotated by one pitch, and the next component suction nozzle 33 is made to front the component take-out position (step S3). In this stage, it is decided whether or not the mounting head
15 section 31 has completed the suction of a specified number (four in this embodiment) of components 34 (step S4). When it has not been completed, the same operation as above will be repeated to suck the specified number of components 34.

 When the suction of the specified number of
20 components 34 has been completed, the step motor 56 of the head feed mechanism section 52 and the step motor 47 of the head positioning mechanism section 41 are simultaneously driven to move the mounting head section 31 onto the board positioning section 24 via the operating frame 30 in
25 accordance with the rotation of the ball thread 54 and then

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position it just above a specified component mounting position of the circuit board 37 by the head positioning mechanism section 41 (step S5). Then, the head elevation mechanism section 51 is driven to mount the components that
5 have been held by the component suction nozzle 33 as sucked thereto onto the circuit board 37 (step S6). After the mounting head section 31 is slightly moved up by the head elevation mechanism section 51, the mounting head section 31 is moved to a position just above the next component
10 mounting position of the circuit board 37 and then positioned by the operations of the head positioning mechanism section 41 and the head feed mechanism section 52, and the rotary member 32 is rotated by one pitch, so that the component to be mounted next is made to front the
15 component mounting position (step S7).

In this stage, it is decided whether or not the mounting of all the components 34 that have been held by the mounting head section 31 as sucked thereto has been completed (step S8). When it has not been completed, the
20 same operation as above will be repeated to mount all the components 34 onto the specified positions of the circuit board 37.

When the specified number of components has been completed at step S8, it is decided whether or not the
25 mounting of all the components 34 distributed to the

component mounting apparatuses 27A through 27D for the circuit board 37 positioned in the board positioning section 24 has been completed (step S9). When it has not been completed, the mounting head sections 31 are moved again above the component supply tables 28A through 28D to repeat the suction of the components 34 from the component supply tables 28A through 28D and the mounting of the components 34 onto the circuit board 37 in a manner similar to the above until the mounting of all the components 34 onto the circuit board 37 will complete. When the mounting of all the components 34 onto the circuit board 37 is completed, each circuit board 37 positioned in the board transfer path 21 is fed by a specified pitch to be positioned in the board positioning sections 24 of the component mounting apparatuses 27A through 27D for the next process (step S10), and an operation similar to the above will be repeated.

In the above component mounting equipment, mutually different components can be mounted on the component supply tables 28A through 28D of the plurality (four in this embodiment) of component mounting apparatuses 27A through 27D provided in parallel to one another along the board transfer path 21. Therefore, when the types and the number of components 34 to be mounted onto the circuit board 37 increase, these components are mounted on the

component supply tables 28A through 28D as distributed into groups classified by type. With this arrangement, since the component supply tables 28A through 28D are mounted with only the components 34 of the respective groups, the
5 tables are not dimensionally increased. Furthermore, since the component supply tables 28A through 28D are installed perpendicularly to the board transfer path 21 at the component mounting apparatuses 27A through 27D, the equipment is not dimensionally increased as a whole without
10 significantly expanding in the direction of the board transfer path 21.

Furthermore, since the mounting head section 31 of the component mounting apparatuses 27A through 27D only operates and the component supply tables 28A through 28D
15 are fixedly installed, the tables become free of vibration regardless of the number of mounted component supply means 12 and 38. Furthermore, the mounting head section 31 sucks at one time a plurality of components 34 from the component supply tables 28A through 28D and successively mounts the
20 components 34 onto the specified portions of the circuit board 37. Furthermore, the component mounting apparatuses 27A through 27D are each provided with a pair of mounting head sections 31 and controls the mounting head sections 31 so that, while one is sucking components 34, the components
25 34 that are held by the other as sucked thereto are mounted

to the circuit board 37. With the above arrangement, even when the types and the number of components 34 to be mounted onto the circuit board 37 increase, the component mounting operation speed can be remarkably increased further than in the conventional apparatus in which the component supply table is fed at a pitch with respect to the rotary type mounting head section.

When the types of circuit boards 37 increase, it can be coped with only by replacing a part of the component supply tables 28A through 28D installed at the component mounting apparatuses 27A through 27D with component supply tables 28A through 28D mounted with required components 34. It is to be noted that the component mounting apparatuses 27A through 27D can be also used singly.

According to the present invention as described above, there is provided a robot type mounting head section in which the component supply tables are installed fixedly, and a plurality of components are sucked at one time from the component supply tables and thereafter transferred to be successively mounted onto the specified portions of the board. With this arrangement, even when the number of components to be mounted onto the board increases, the component mounting operation speed can be remarkably increased further than in the conventional structure in which the component supply table is fed at a pitch with

respect to the rotary type mounting head section. Furthermore, since the laterally provided pair of first and second mounting head sections are mutually controlled in operation in accordance with a timing at which, when one is
5 located on the component supply table, the other is located on the board positioning section. With this arrangement, components can be mounted onto single board by a plurality of mounting head sections, and therefore, the component mounting operation speed can be further increased.

10 Furthermore, according to the component mounting equipment of the present invention, by mounting mutually different components onto the component supply tables of the component mounting apparatuses arranged in parallel to one another, even when the types and the number of
15 components to be mounted onto the circuit board increase, the equipment is not dimensionally increased as a whole without significantly expanding in the direction of the board transfer path. Furthermore, the component mounting operation speed can be further increased. In this case,
20 there may be provided the structure in which all the components to be mounted onto single board are distributed into groups by type and the components of each group are mounted on component supply tables as assigned to them installed at the respective component mounting apparatuses.
25 With this arrangement, when the types of boards increase,

it can be coped with only by replacing a part of the component supply tables of the component mounting apparatuses with component supply tables mounted with the required components.

5 Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and
10 modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

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CLAIMS:

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1. A component mounting apparatus comprising:

a pair of component supply tables on which components are accommodated and which are arranged on opposing sides of a board mounting position where a board is positioned;

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a first mounting head section for successively picking up the components at one of the component supply tables and thereafter successively mounting the picked-up components onto the board; and

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a second mounting head section for successively picking up the components at the other of the component supply tables and thereafter successively mounting the picked-up components onto the board,

wherein each of the first and second mounting head sections are independently moveable.

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2. The component mounting apparatus as claimed in claim 1, further comprising a controller for mutually controlling the first and second mounting head sections in accordance with a timing at which, when one of the first and second mounting head sections carries out a component picking-up operation for picking up the components from the component supply table, the other of the first and second mounting head sections carries out a

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component mounting operation for mounting the picked-up components onto the board.

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3. The component mounting apparatus as claimed in claim 1, wherein one of the first and second mounting head sections has a plurality of component suction nozzles sucking the components at one time.

4. The component mounting apparatus as claimed in claim 2, wherein one of the first and second mounting head sections has a plurality of component suction nozzles sucking the components at one time.

5. The component mounting apparatus as claimed in claim 1, wherein said each of said first and second mounting head sections is moveable in two directions which are perpendicular to each other.

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6. A component mounting method comprising steps of:
picking up, by a first mounting head section,
components from one of a pair of component supply tables on which components are accommodated and which are arranged on both sides
of a board mounting position where a board is positioned, the

25

first mounting head section successively picking up the components at one of the component supply tables;

5 thereafter successively mounting the components picked up by the first mounting head section onto the board;

 picking up, by a second mounting head section, components from the other of the pair of component supply tables, the second mounting head section successively picking up the components at the other of the component supply tables; and

10 thereafter successively mounting the components picked up by the second mounting head section onto the board,

 wherein the picking-up and mounting steps of the first mounting head section and the picking-up and mounting steps of the second mounting head section are independently carried out, and the first mounting head section and the second mounting head section are each independently moveable.

15 7. The component mounting method as claimed in claim 6,
20 wherein the picking-up step of the first mounting head section and the mounting step of the second mounting head section are simultaneously carried out, and the mounting step of the first mounting head section and the picking-up step of the second mounting head section are simultaneously carried out.

ABSTRACT OF THE DISCLOSURE

There is provided a plurality of component mounting apparatuses for sucking a plurality of components by a mounting head section and successively mounting the components onto a board located at a board positioning section. By arranging the component mounting apparatuses in parallel to one another, and a board transfer path is provided so that it penetrates the component mounting apparatuses. Even when the number of components to be mounted onto the board increases, the components are mounted on the component supply tables of the component mounting apparatuses as distributed thereto, and therefore, the whole apparatus is not dimensionally increased. The component supply tables are fixedly installed to become free of vibration, and the mounting head section executes the suction and the mounting of the plurality of components. Therefore, the component mounting operation speed can be remarkably increased.

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Fig. 1

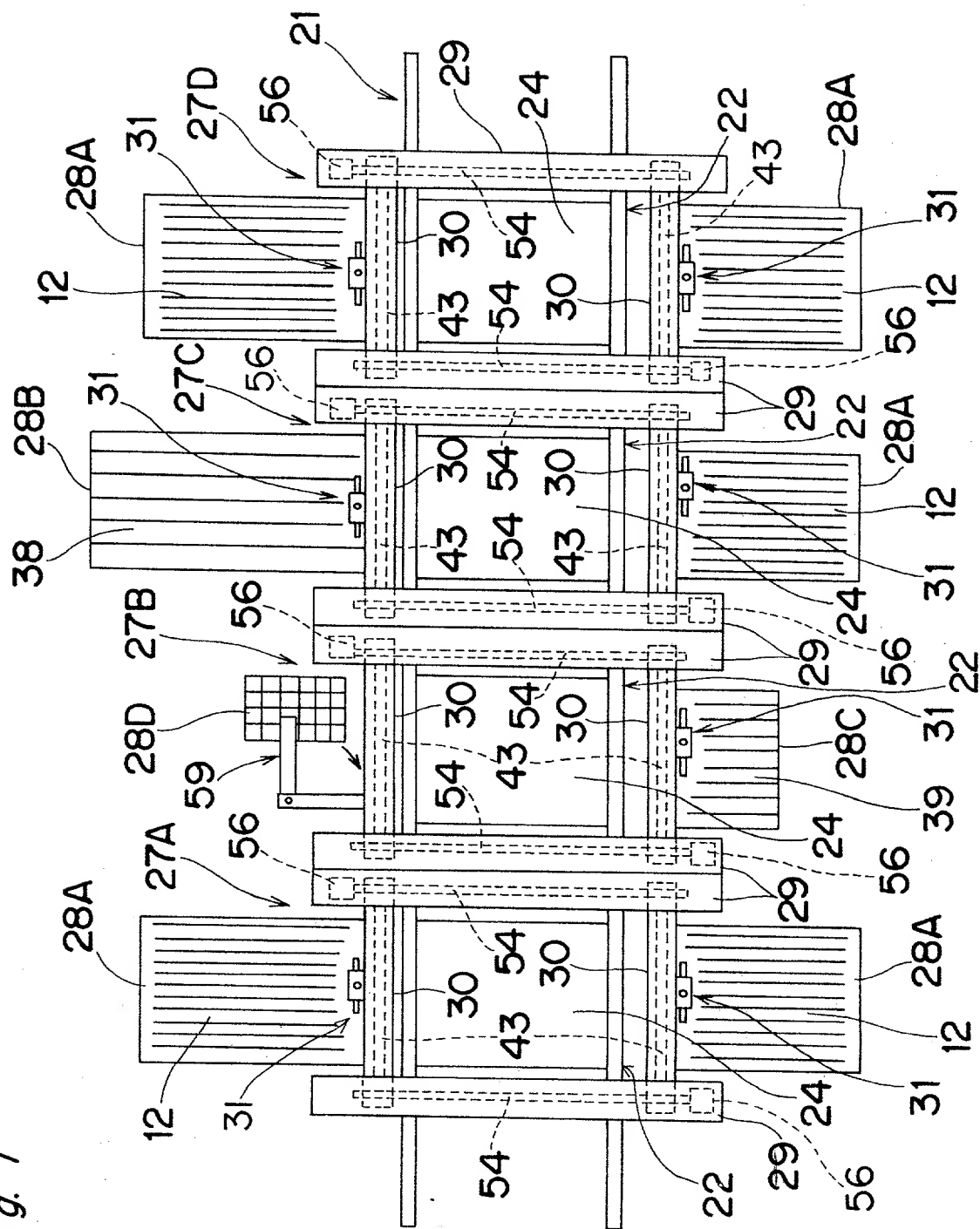


Fig. 2

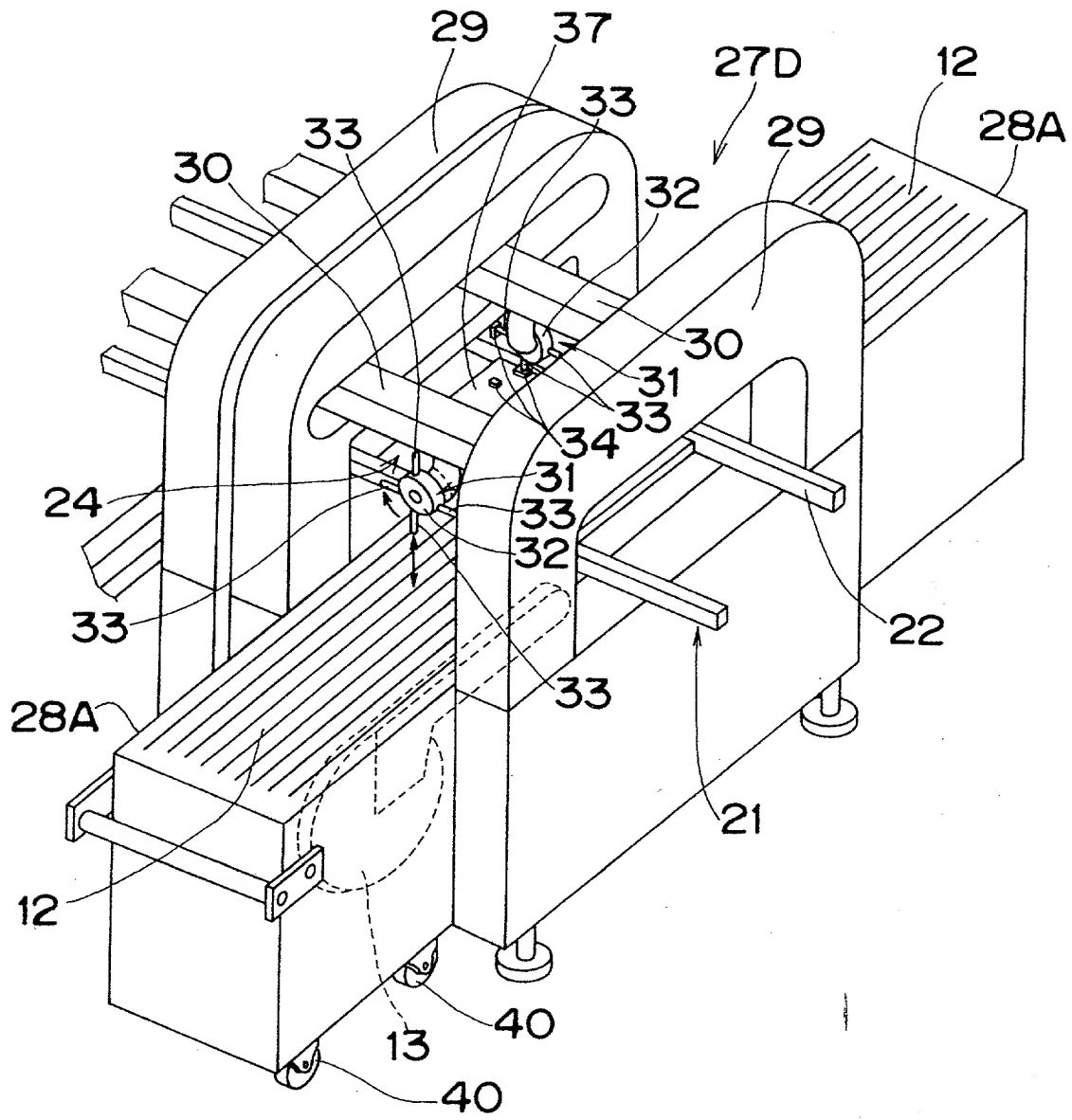


Fig. 3

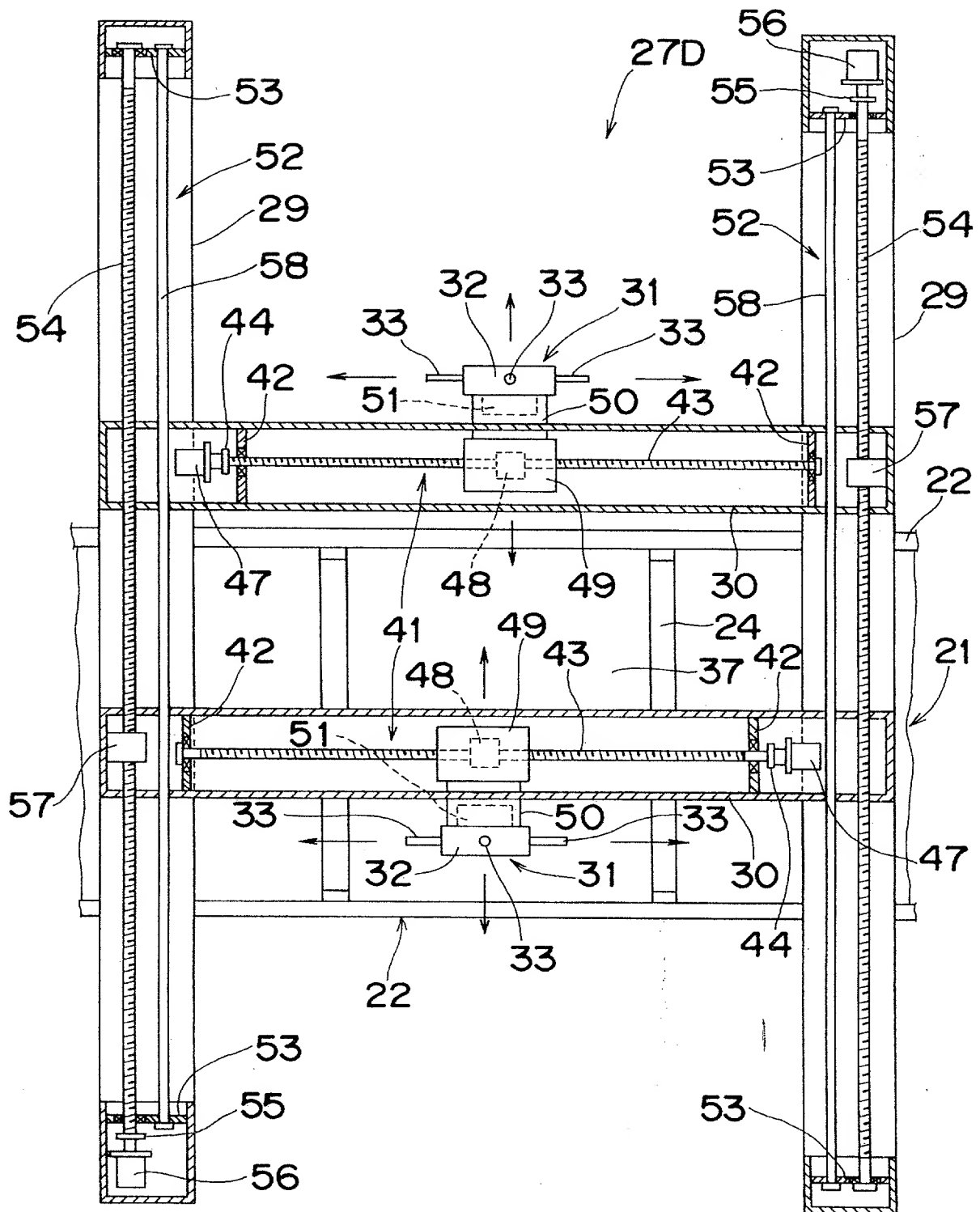


Fig.4

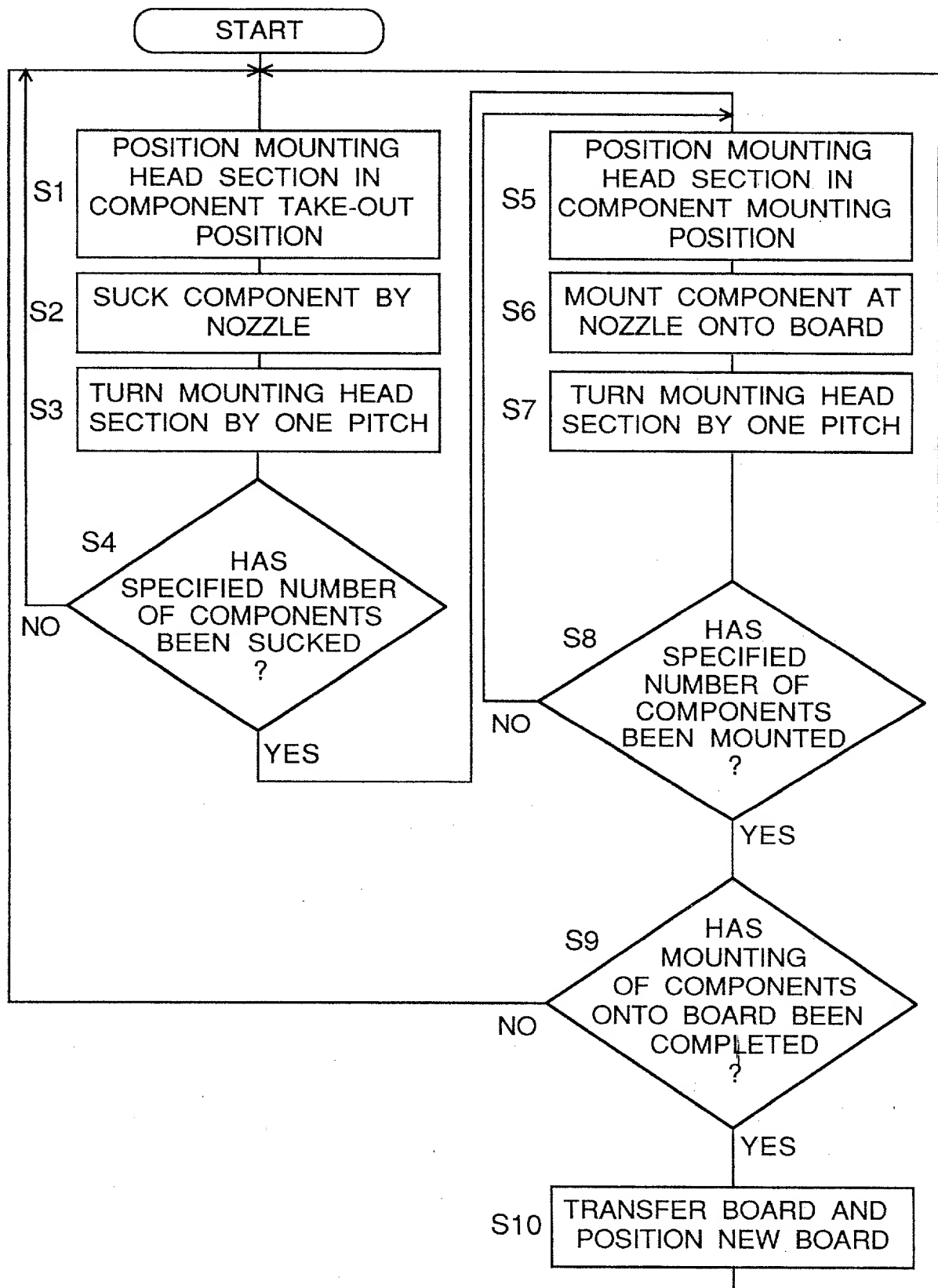


Fig.5

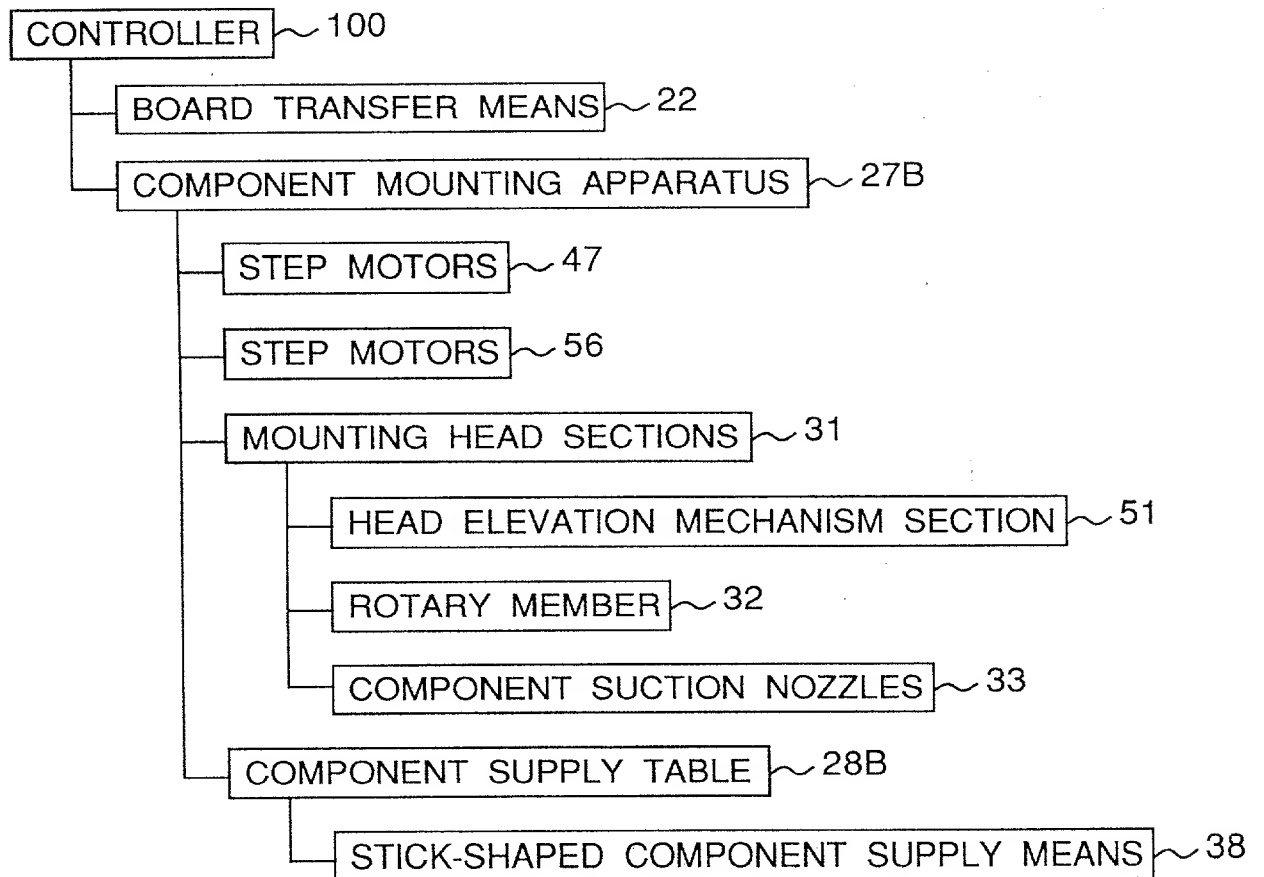


Fig. 6 PRIOR ART

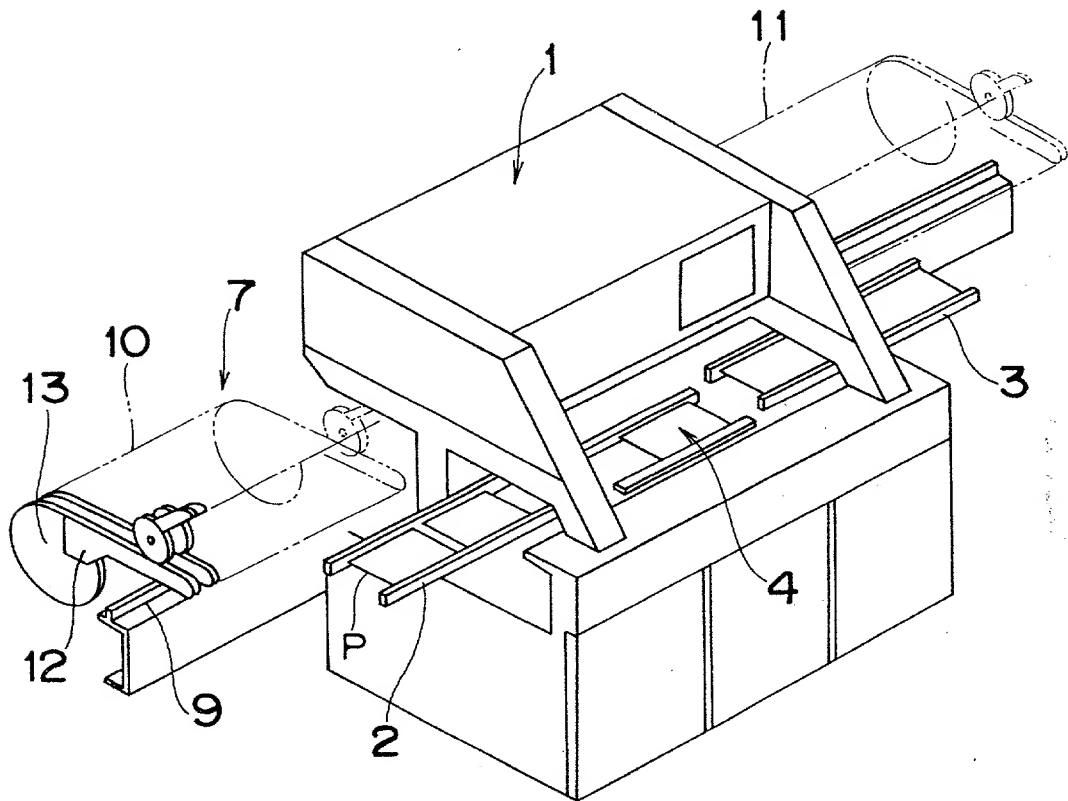
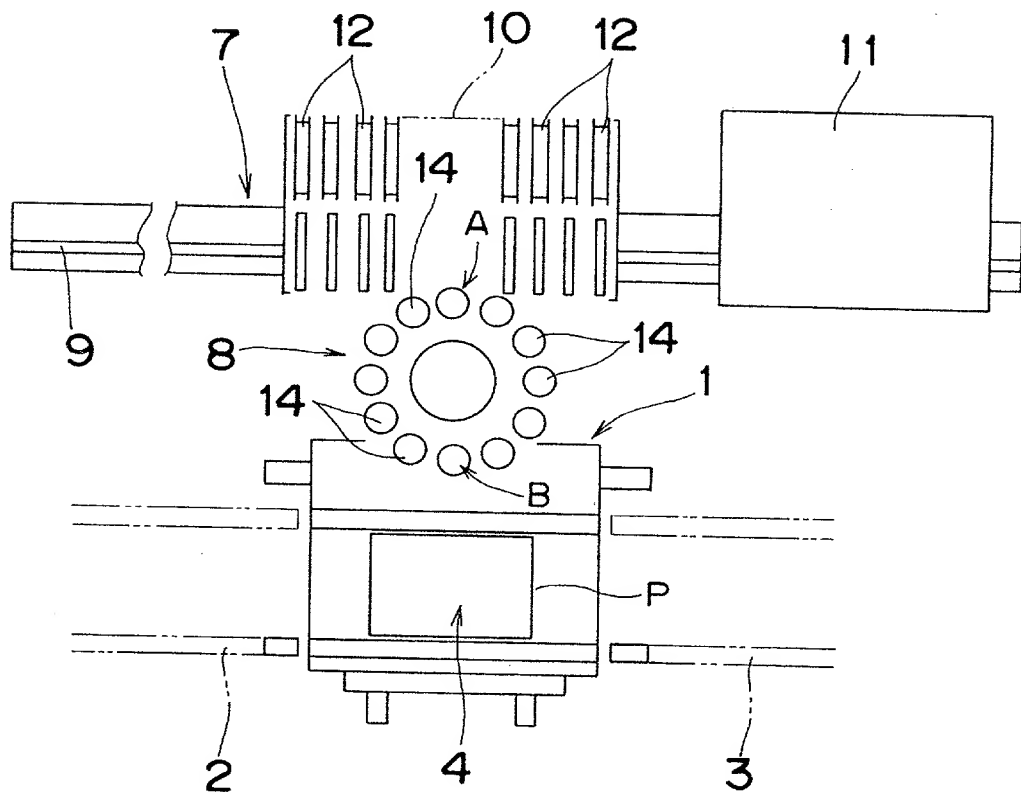


Fig. 7 PRIOR ART



DECLARATION AND POWER OF ATTORNEY FOR U.S. PATENT APPLICATIONS

(X) Original () Supplemental () Substitute () PCT () DESIGN

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: COMPONENT MOUNTING APPARATUS AND METHOD, AND
COMPONENT MOUNTING EQUIPMENT

of which is described and claimed in:

- (X) the attached specification, or
 () the specification in the application Serial No. _____ filed _____;
 and with amendments through _____ (if applicable),
 () the specification in International Application No. PCT/ _____, filed _____, and as amended on _____ (if applicable).

I hereby state that I have reviewed and understand the content of the above-identified specification, including the claims, as amended by any amendment(s) referred to above.

I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application in accordance with Title 37, Code of Federal regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (and §172 if this application is for a Design) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

| COUNTRY | APPLICATION NO. | DATE OF FILING | PRIORITY CLAIMED |
|---------|-----------------|----------------|------------------|
| Japan | 7-286969 | Nov. 6, 1995 | (X) YES () NO |
| _____ | _____ | _____ | () YES () NO |
| _____ | _____ | _____ | () YES () NO |
| _____ | _____ | _____ | () YES () NO |
| _____ | _____ | _____ | () YES () NO |
| _____ | _____ | _____ | () YES () NO |

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

| SERIAL NO. | U.S. FILING DATE | STATUS |
|------------|------------------|----------------------------------------|
| _____ | _____ | () Patented () Pending () Abandoned |
| _____ | _____ | () Patented () Pending () Abandoned |
| _____ | _____ | () Patented () Pending () Abandoned |

And I hereby appoint V. M. Creedon, Reg. No. 17111, John T. Miller, Reg. No. 21120, John T. Fedigan, Reg. No. 24347, Michael R. Davis, Reg. No. 25134, Matthew M. Jacob, Reg. No. 25154, Jeffrey Nolton, Reg. No. 25408, Henry M. Zykorie, Reg. No. 27477, and Michael Stone, Reg. No. 32442, who together constitute the firm of WENDEROTH, LIND & PONACK, jointly and severally, attorneys to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith.

I hereby authorize the U.S. attorneys named herein to accept and follow instructions from AOYAMA & PARTNERS as to any action to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and myself. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by me.

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Effective March 7, 1988

| | | | |
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I further declare that all statements made herein of my own knowledge are true, and that all statements on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1st Inventor Kanji Hata Date October 31, 1996
 2nd Inventor Noriaki Yoshida Date October 31, 1996
 3rd Inventor _____ Date _____
 4th Inventor _____ Date _____
 5th Inventor _____ Date _____
 6th Inventor _____ Date _____

The above application may be more particularly identified as follows:

U. S. Application Serial No. _____, Filing Date _____

Applicant Reference Number 524285, Atty Docket No. _____

Title of Invention COMPONENT MOUNTING APPARATUS AND METHOD, AND
COMPONENT MOUNTING EQUIPMENT

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THE COMMISSIONER IS AUTHORIZED
TO CHARGE ANY DEFICIENCY IN THE
FEE FOR THIS PAPER TO DEPOSIT
ACCOUNT NO. 23-0975.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of :
Kanji HATA et al. :
Serial No. [NEW] : Attn: APPLICATION BRANCH
Filed January 21, 1998 : Docket No.: 177/527415

COMPONENT MOUNTING APPARATUS
AND METHOD, AND COMPONENT MOUNTING
EQUIPMENT

(Continuation of 08/740,992
filed November 5, 1996)

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents,
Washington, D.C.

Sir:

Kindly amend the above-identified application as follows.

IN THE SPECIFICATION:

Please amend the specification as follows:

Page 2:

Line 13, insert --, two component supply tables 10 and
11-- after "7".

Line 14, delete "two component supply tables 10 and 11".

Line 19, insert --a-- after "generally".

Line 20, delete "the" before "parts".

Line 22, change "as" to --and--.

Page 3:

Line 22, change "incessantly" to --continuously--.

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in the description of-- after "which".

Line 24, change "claimed" to --described--.

Page 8:

Line 6, change "claimed " to --described--.

Page 9:

Line 13, change "claimed" to --described--.

Line 21, change "claimed" to --described--.

Page 10:

Line 15, change "claimed" to --described--.

Line 24, change "claimed" to --described--.

Page 11:

Line 6, change "claimed" to --described--.

Page 13:

Line 8, delete "a".

Page 14:

Line 5, delete "a".

Page 15:

Line 2, change "29, and they" to --29. The operating frames--.

Page 19:

Line 16, change "When" to --If--.

Page 20:

Line 19, change "When" to --If--.

Page 21:

Line 3, change "When" to --If--.

Line 10, change "will" to --is--; "complete" to --completed--.

Page 24:

Line 7, insert --a-- after "onto".

IN THE ABSTRACT:

Please amend the abstract as follows:

Line 6, delete "By arranging the" insert --The-- before "component"; --are arranged-- after "apparatuses".

Line 14, insert --so as-- after "installed".


R E M A R K S

The present Preliminary Amendment is submitted to make the same changes in the specification and abstract as in the earlier application. Please note that a second preliminary amendment, modifying the claims, will be submitted shortly. The Examiner is requested to delay action on this application until the preliminary amendment is received.

Respectfully submitted,

Kanji HATA et al.

By



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Registration No. 40,268
Attorney for Applicants

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January 21, 1998